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Technical Aspects for the Development of an Infrastructure in a New Area

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Abstract: ***The infrastructure of a new area, mainly the water supply, drainage and sewerage system are vital for urbanization. While planning for these infrastructures all the aspects must be studied properly. Pumping of drainage system and sewerage system is biggest issue. This study aim at designing a collection system for a new area in such a way so as to avoid pumping of drainage and sewerage system and to develop a self-sustainable area.***

Keywords: Avoid pumping of drainage and sewerage system

1. Introduction

Infrastructure of a new area is composed of public and private physical improvements such as roads, water supply, sewers, drainage, electrical grids and telecommunications. Water system works on pressure which can either be created by pumping or elevation head .If we want to develop an area for 24x7 water supplies then water pressure generated in the distribution system must be from elevation head and source water level must be maintained. Sewerage and drainage system works on pressure as well as gravity but it is always suggested to have both the system to work on gravity as pumping of drainage and sewerage system is a biggest issue in long run.

2. Objectives of Study

a) Topographical survey of the area
b) Invert level and high flood level of the existing nearby drain for excess Storm Water Disposal.
c) Determing the ground level of the road top according to Storm Water Disposal high flood level so as to avoid pumping in storm water disposal.
d) Design of underground sewage collection system and location of f Sewage Treatment Plant (STP)
e) Design of underground Storm Water collection and Disposal system
f) Any municipal water supply or source of water(surface or sub surface water)
g) Design of domestic water supply system.
h) Reuse of treated waterwater in green and flushing purposes.

3. Design Considerations

In designing waste water collection, treatment and disposal system, planning generally begins from the final disposal point going backwards to give an integrated and optimum design suit the topography and the available hydraulic head.

1) Design Period

Sewerage projects may be designed normally to meet the requirements over a thirty year period after their completion. The period between design and completion should also be taken into account which should be between two to three years depending on the type and size of the project. Design periods for the project components may be designed to meet the periods mentioned below in table no1

Table 1: Design Period

S. No.	Items	Design Period (Years)
1	Pumping	
i)	Pump House(civil works)	30
ii)	Electric motors and Pumps	15
2	Water Treatment units if required	15
3	Pipe connections to the several treatment units and other small appurtenances	30
4	Raw water and clear water conveying mains	30
6	Distribution System	30

a) Design Parameters

- *Population*
  The population is very important parameter because of water supply quantity is predominating.
- *Rate of Water Supply*
  Wastewater quantity may be assumed to be 80% of the quantity of water supply. The sewers should be designed for a minimum of 135 lpcd.
- *Slope/Gradient*
  Slope depends upon the topography of ground and levels. Slope is also another important parameter because the rate of flow is depends upon the amount of slope.
- *Peak Factor*
  The peak factor or the ratio of maximum to average flow depends upon contributory population and the following values are recommended. These peak factors will be applied to the projected population for the design year considering an average wastewater flow based on allocation.

b) Velocity

The sanitary sewer is designed to obtain adequate scouring velocities at the average or at least at the maximum flow at the beginning of the design period for a given flow and slope. Velocity is little influenced by pipe diameter. The recommended slope for minimum velocity is 0.60 metre/sec and maximum velocity is 3.00 metre/sec.

c) Pipe Size

The pipe size should be decided on the basis of ultimate design peak flow and the permissible depth of flow. The minimum diameter of public sewer may be 150 mm. In hilly areas, where extreme slope are prevalent, the size of sewer may be 100 mm

d)Depth of Cover

1 m cover on pipeline is normally sufficient to protect the pipe lines from external damage

e) Manholes

Manholes are interconnecting between two or more sewers and to provide entry of sewers. Manholes are used to building connections and junction chambers.

f) Hydraulic Design Equation

Normally, The Manning's equation is used most commonly for the design of sanitary sewers because it is efficient, popular and fully satisfied the experimental results and same is used for this design.

The Manning's Equation is as below,

V = (1/n) x R (2/3) x S (1/2)

Where,

V = Velocity in metre/sec

n = Friction Factor

= 0.011 (For Plastic smooth pipe)

= 0.013 (For Cement-concrete pipe)

R = Hydraulic Radius in metre

(C/s area of flow in sq. metre)

= Wetted perimeter in metre

S = Slope of Energy Grade Line

Wastewater = 80 % of water supply per person

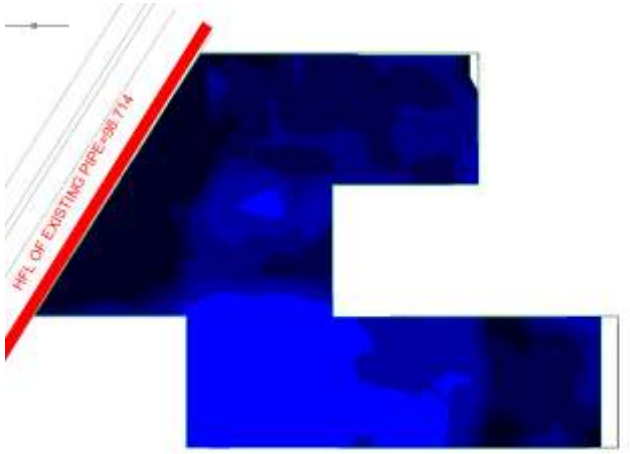
4. Case Study- 7acre New Township at Rohtak, Haryana

a)General Information

The site is located in haryana so all the norms of planning a layout and population forecast will be governed by Haryana Development Authority.

b)Topographical survey of the area

After doing topographical survey of site ,Digital Elevation model is developed .It shows that site elevation levels varies from 99.19 to 99.83 and high flood level of storm water disposal is 98.714.



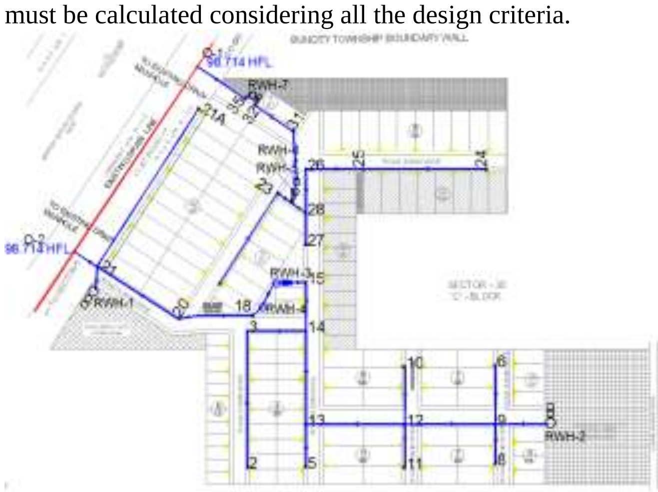
Elevations Table			
Number	Minimum Elevation	Maximum Elevation	Color
1	99.19	99.31	
2	99.31	99.35	
3	99.35	99.38	
4	99.38	99.41	
5	99.41	99.83	

Figure 1: Digital Elevation Model of the site

c) Determing the ground level of the road top according to Storm Water Disposal high flood level so as to avoid pumping in storm water disposal

As per the design considerations minimum cover on the pipe must be 1 m that means (99.83-(1+dia of pipe)) will be the start invert pipe of storm water drainage system. So if we design as per actual site then invert level of storm water drainage system will definitely go below the existing HFL of the drainage system. This may conclude that we have to propose the pumping for the ultimate disposal of the storm water drainage. Pumping of storm water drainage will not at all be suggested for long and efficient run of an area. So in this case we have to fill earth in order to place our pipe above HFL. Now the question arises how much filling?

So to have minimum filling required for the disposal of storm water system. Firstly storm water network will be designed and minimum ground level at different locations must be calculated considering all the design criteria.



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All the start and stop node is marked and catchment area of each drain is determined and discharge of each drain is calculated. To carry the calculated discharge pipe carrying capacity is calculated so as to achieve minimum self-cleaning velocity and maintaining d/D ratio.

Hydraulic Statement of Drainage Scheme

Particulars		length	Total Peak Discharge	Dia of Pipe	Slope of pipe	Corresponding Vs/Vf	Actual Velocity (Vs)	Correspo ndingDs/Df	RatioQs/Qf
From node	To node	m	cumecs (Qs)	mm	1in…		m/sec		
R1	21	8	0.009	200	405	1.0	0.6	0.5	0.5
2	3	61	0.008	200	351	0.9	0.6	0.4	0.4
3	14	9	0.009	200	395	1.0	0.6	0.5	0.5
5	13	20	0.004	200	181	0.7	0.6	0.2	0.1
6	9	26	0.004	200	199	0.7	0.6	0.3	0.1
R2	9	23	0.004	200	200	0.7	0.6	0.3	0.2
8	9	19	0.004	200	180	0.7	0.6	0.2	0.1
9	12	41	0.014	200	501	1.1	0.6	0.7	0.8
10	12	25	0.004	200	199	0.7	0.6	0.3	0.2
11	12	19	0.004	200	199	0.7	0.6	0.2	0.1
12	13	44	0.023	250	596	1.1	0.7	0.7	0.8
13	14	48	0.033	300	800	1.1	0.6	0.7	0.8
14	15	15	0.044	350	888	1.1	0.7	0.7	0.8
15	R3	14	0.044	350	894	1.1	0.7	0.7	0.8
R3	R4	13	0.045	350	907	1.1	0.7	0.7	0.8
R4	18	8	0.045	350	938	1.1	0.6	0.7	0.8
18	20	22	0.047	350	908	1.1	0.7	0.7	0.8
20	21	38	0.048	350	100	0.9	1.5	0.4	0.3
21	O2	17	0.068	400	1113	1.1	0.7	0.8	0.9
22	23	46	0.012	200	450	1.1	0.6	0.6	0.6
23	R5	10	0.012	200	457	1.1	0.6	0.6	0.7
24	25	56	0.012	200	451	1.1	0.6	0.6	0.7
25	26	25	0.013	200	498	1.1	0.6	0.6	0.7
26	28	20	0.015	200	495	1.1	0.6	0.7	0.9
27	28	27	0.002	200	100	0.5	0.6	0.2	0.1
28	R5	6	0.017	250	582	1.0	0.6	0.6	0.6
R6	31	26	0.031	300	803	1.1	0.6	0.7	0.8
31	32	25	0.034	300	810	1.1	0.6	0.7	0.8
32	R7	8	0.034	300	833	1.1	0.6	0.7	0.9
R7	35	9	0.034	300	818	1.1	0.6	0.7	0.9
35	O1	20	0.035	300	788	1.1	0.6	0.7	0.9
21a	21	88	0.010	200	400	1.0	0.6	0.5	0.5
R5	R6	5	0.030	300	833	1.1	0.6	0.7	0.8

Based on the above design considering invert level of outgoing storm water drainage as 98.714 the minimum ground level is calculated

Particulars		Ground Level (m)		Invert level (m)	
From node	To node	Upper From Node	Lower to node	Upper From Node	Lower to node
		m	m	m	m
R1	21	100.20	100.18	98.95	98.93
2	3	100.83	100.66	99.58	99.41
3	14	100.66	100.64	99.41	99.39
5	13	100.81	100.70	99.56	99.45
6	9	100.98	100.85	99.73	99.60
R2	9	100.97	100.85	99.72	99.60
8	9	100.96	100.85	99.71	99.60
9	12	100.85	100.77	99.60	99.52
10	12	100.90	100.77	99.65	99.52
11	12	100.86	100.77	99.61	99.52
12	13	100.77	100.70	99.47	99.40
13	14	100.71	100.65	99.35	99.29
14	15	100.65	100.63	99.24	99.22
15	R3	100.63	100.62	99.22	99.20
R3	R4	100.62	100.60	99.20	99.19
R4	18	100.60	100.60	99.19	99.18
18	20	100.60	100.57	99.18	99.16
20	21	100.57	100.19	99.16	98.78
21	O2	100.19	100.18	98.73	98.71
22	23	100.30	100.20	99.05	98.95
23	R5	100.20	100.18	98.95	98.93
24	25	100.41	100.28	99.16	99.03
25	26	100.28	100.23	99.03	98.98
26	28	100.23	100.19	98.98	98.94
27	28	100.46	100.19	99.21	98.94
28	R5	100.19	100.18	98.89	98.88
R6	31	100.18	100.15	98.82	98.79
31	32	100.15	100.12	98.79	98.76
32	R7	100.12	100.11	98.76	98.75
R7	35	100.11	100.10	98.75	98.74
35	O1	100.10	100.07	98.74	98.71
21a	21	100.40	100.18	99.15	98.93
R5	R6	100.19	100.18	98.83	98.82

In this way we will get minimum ground level required for the road in order to avoid pumping.

d)Design of underground sewage collection system and location of Sewage Treatment Plant (STP)

As per the HUDA norms, total population of the site is calculated:

S. No.	Usage Type	Total Number	Total Population
1	Residential	128	population @13.5 person per plot=1728
2	Community Facility	1	population @10 person per sqm,FAR:1=282
3	Commercial	1	population @10 person per sqm,FAR:1.75=195
3.1	Commercial Visitors @ 75%		146
3.2	Commercial Retailers @ 25%		49

Based on above suggested ground level sewerage system must be designed and location of STP will be selected .As this site is very small so phytorid treatment based is proposed.

e) Design of underground Storm Water collection and Disposal system

As the water level of this area is very up so it is proposed to recharge the groundwater as much as possible. So all the storm water is separately collected and then storm water will be passed through oil and grease trap then desilting chamber and finally to rain water harvesting pit and overflow of the RWH Pit will be further connected to nearby existing drain.Network for carrying the storm water is designed based on the above said design criteria and considering above proposed ground level.

f) Any municipal water supply or source of water(surface or sub surface water)

Another important aspect is to find the source of water .In this site there is a scarcity of water still municipal water supply is available.So main source of water supply is municipal water supply but 2 tubewell is proposed for supplying water in emergency period. The pressure in municipal water pipeline is 10 m only. There are G+ 3 houses i.e. 22 m head is required at terminal point but the pressure in the pipeline is less. So UGT is proposed to store water and further water is pumped in OHT having 25 m staging height and further water will be supplied through distributed pipeline.

g)Design of domestic water supply system

As there is scarcity of water in this area so one day storage of water is suggested here. Water demand is calculated as shown below:

Total Water Requirement			
Domestic Water Demand			
S. No.	Usage Type	Water Requirement (in lpcd)	Water Requirement (in kld)
1	Residential	90	155.520
2	Community Facility	15	4.230
3	Commercial		
3.1	Commercial Visitors @ 75%	15	2.194
3.2	Commercial Retailers @ 25%	45	2.194
Total Water Demand			164.138
Adding 15% of UWF			24.621
Grand Total Water Demand			188.758
2	Total Fire demand		46.957
Considering fire demand @ 8 hr			15.652
Grand Total Water Demand			251.368
Capacity of Underground Tank			125.000
Capacity of Overhead Tank			125.000

In order to minimize the losses in the distribution system, it is proposed to lay the pipeline in loop.

h)Reuse of treated waterwater in green and flushing purposes

It is proposed to reuse the treated waste water in green and flushing purposes so the domestic water demand is reduced. Refuse generated from the STP will be used as manure in the green area.

After doing all the above said design further all the network will be superimposed on single drawing so as to check all the crossing of pipeline and final invert levels of the pipeline will be executed.

5. Conclusion

From the above said method we can conclude that by this method of designing any new site we can avoid pumping in the drainage system and minimum filling of earth required for the site will be calculated and we can plan accordingly rest of our infrastructure facilities.

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